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# SCIENCE

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NAVAL RESEARCH<sup>1</sup>

## CONTENTS

<i>Naval Research: CAPTAIN C. S. McDOWELL</i>	607
<i>Some New Fundamentals in Plant Biology, Agriculture and the Food Problem: DR. O. W. WILLCOX</i>	609
<i>Scientific Events:</i>	
<i>A Biological Study of Neritic Waters in the Gulf of Maine; Work of the Rockefeller Foundation; Gift to New York University Medical School; The International Corn Borer Conference; The Texas Academy of Science</i>	613
<i>Scientific Notes and News</i>	616
<i>University and Educational Notes</i>	620
<i>Discussion:</i>	
<i>Glacial Geology and the Vermont Flood: PROFESSOR JULIUS W. EGGLESTON. The Species of Paramecium and the Thyroid Question: PROFESSOR WALDO SHUMWAY. The Smelt in Lake Michigan: CHARLES W. CREASER</i>	621
<i>Quotations:</i>	
<i>Humphry Davy</i>	623
<i>Scientific Books:</i>	
<i>Eddington on the Nature of the Physical World: PROFESSOR LEIGH PAGE</i>	624
<i>Scientific Apparatus and Laboratory Methods: Practical Hints in the Laboratory Studies of Protozoa and Earthworm: T. T. CHEN</i>	626
<i>Special Articles:</i>	
<i>The Photoelectric Effect as Related to the Size and Surface Conditions of Carbon Particles: L. G. MORELL and WESLEY E. THOMAS. The Effect upon Digitalis purpurea of Radiation through Solarized Ultra-violet-transmitting Glass: ADELIA MCCREA. Chromosome Morphology in Zea mays: BARBARA MCCLINTOCK</i>	627
<i>Philadelphia Meeting of the American Association of Museums: DR. LAURENCE VAIL COLEMAN</i>	630
<i>Science News</i>	x

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WHEN the war ended ten years ago there was a universal feeling throughout the civilized world that there must not be another war. I am sure that such feeling still persists among intelligent, thinking people. There is, though, a group who think that the way to prevent future wars is for our country to set an example to the world by disarming, and who, I believe, would desire to have each individual in the country sign a pledge not to take part in a future war. This group is, in the main, made up of patriotic citizens who are actuated by an honest desire to have affairs between nations settled without resorting to war. They have not, however, in my opinion, sufficiently studied history, nor have they properly taken into account human nature and national hysteria.

There is another group who just as earnestly desire peace, but who believe that the best guarantee for peace is an efficient, prepared navy for enforcing national policies and protecting national ideals.

Our navy plays the same part in international affairs, in being the force behind our international policies and our interpretations of international law, as do the national enforcement agencies and local police in making effective national and local laws.

We have gradually adopted or developed certain policies which we believe express our American ideals. Among others, these include the Monroe Doctrine, the open door to the world's markets, the freedom of the sea and the freedom of the Panama Canal. The Monroe Doctrine has been considered so vital for the peace and security of this country that we have always refused to consider it a subject of arbitration in any international court. President Roosevelt stated a fact in saying, "The Monroe Doctrine is as strong as the United States Navy, and no stronger."

The causes of war are many; among others may be mentioned the pressure of increasing populations and national desires for obtaining greater resources as represented by natural or artificial wealth. Any steps the pacifists can take which will tend to harness the above forces will be welcomed by every one; but, as long as these forces remain uncontrolled, the possibility of war must be recognized. It is easy to scrap navies and disband armies, but it is not so easy to control the causes of war.

<sup>1</sup> Read before Section M, American Association for the Advancement of Science, New York, December, 1928.

We have a rich, prosperous nation; we are dedicated to liberty for the individual; we believe in the square deal, and it is necessary for us to guard our heritages and to be prepared to defend them if required. There is much confusion of thought at present on the subject of world peace and a means to obtain it, and some feeling that our presentation of the Kellogg Treaty for abolishment of war is inconsistent with our efforts to strengthen our navy up to a parity with that of any other nation. As a matter of fact, these two steps are both designed to insure world peace, and they complement each other. Let us, then, see our navy first as an agent to prevent war, and second as our first line of defense in case war becomes an actuality.

I have presented this preamble to give the background and lead up to the part the scientist must play. Our navy, in order to carry out its mission, must be efficient and modern. It is my desire to present to the scientists of this country the part they must of necessity play, in providing the country with the best first line of defense obtainable, and in helping to guard our national heritages.

Though the desire of the naval officer and the entire navy is strong for peace, the navy must leave no stone unturned in its plans for effective preparedness. The people of the country decide when a war is to be, and the navy must be prepared whenever that decision is made.

There is a romantic spirit in all men, and it is particularly developed in the research worker. Down through the ages the romance of the sea and the navy has appealed to the adventurous spirit of man, and the navy can well profit by fostering comradeship with the inquisitive civilian.

There are problems to be solved and new devices and methods to be perfected whose major purpose is the improvement of the fleet's effectiveness in war. There are other researches and developments which will incidentally increase the effectiveness of war-time efforts but which also will have far-reaching effects in advancing peace-time civilization.

No matter how diligent we may be in peace time in perfecting methods, means and apparatus to serve most effectively in war, an actual war will present new situations and new problems. To meet such problems and situations, we require all sorts of specialists, each supreme in his own field, all of them navy-wise as to conditions to be met, and all trained in coordination, to realize the common goal.

We learned during the World War that the scientist and the research man had to be utilized to the utmost. The type of mine used in the North Sea barrage, the use of gas, the development of listening and other submarine detection devices, new means of communi-

cation and sound ranging, to mention only a few of the important developments, were all brought out under the competitive stress of conflict. All of these developments would have been more effective if they had been available and we had been prepared to use them immediately on our entry into the war.

The directive coordination of naval research should be conducted both in peace and in war by the professional naval officer. This involves no particular difficulty, provided the research workers and the naval officer have learned to speak each other's language and have a general understanding of each other's technique. This mutual understanding and appreciation must be developed by personal contacts and by working together on common problems. It takes time to develop the cooperative and coordinated spirit between these two groups, and it should be accomplished during peace time.

In addition to developing an organization of research workers, trained to think in naval terms and to work with naval officers, who will be available to solve such problems as may arise during a war, it is desirable that men in the university and industrial laboratories be utilized to help solve naval problems now, in peace time.

In fact, the best way to develop nuclei of naval-minded research men is assigning, to groups or individuals, certain problems in which the navy is interested and establishing working arrangements between the civilian and the naval officer.

Certain desirable naval developments have direct application to the merchant marine and other outside activities. The navy has, in the past, led in many developments which have had wide usage, and the navy should continue a progressive policy of developing new methods and apparatus which may have general use, as well as serve special naval purposes. To enumerate but a few: there are new and more economical methods of propulsion to be developed for all classes of craft; there are innumerable problems to be solved in aviation; there are means to be developed for safe navigation in foggy weather, both at sea and in the air; there are many new metal alloys to be discovered, especially non-corrosive alloys to meet naval conditions, and there are many improvements to be made in communications.

Now, if we will accept the desirability of bringing the civilian research man into contact with the navy, we can investigate the best means of providing a skeleton organization for peace-time use with the idea of expanding it to meet war demands.

We might well start by listing the various special branches of science which might be involved in our problems. This will be a fairly large list, for we will find after a little reflection that nearly every scientific

specialty bears some relationship to the navy's varied problems. Then it is suggested that the National Research Council be requested to help select three or four representative men in each specialty who can be appointed with appropriate rank in a naval research reserve. It is proposed to have these reserve officers become acquainted with the navy by inviting them to make short cruises with various units of the fleet. It might also be found desirable to call some of them, at times, to active duty at the Naval Research Laboratory at Bellevue.

It would probably work out that in certain localities there would be a number of research reserve officers who could be brought together as a local body with contact with some local naval activity and that special naval problems could be assigned to such a local group.

The central office of the research organization in the department should maintain contacts with the local groups or individuals, and encourage reports covering scientific developments that might be of interest in any way to the navy. The classifying, correlating and applying of the information received would require considerable talent in the central office, but the results would well justify all the efforts expended.

We have been discussing a senior class of research men, but assistants will also be required who might well be inducted into this reserve during their post-graduate period, and as they become more experienced in their later civilian work be advanced to the senior class.

It is believed that the navy would materially benefit by establishing a certain number of navy research fellowships at representative technical schools. It would be proposed to have the research students holding these fellowships carry out their researches on problems assigned by the navy. It would be desirable to establish these naval fellowships at universities where senior research reserve officers are attached. The student research man would then be able to carry out his assigned work under the guidance and direction of one or more experienced research men who would also be directly interested in the naval problem. The navy would thus obtain important data and information, and at the same time would be providing for the training of research men and providing these men with some idea of navy atmosphere. These research students, after completing their fellowship and obtaining their doctor's degree, would be commissioned in the research reserve.

Individual naval officers, or a naval activity, could profitably be assigned to keep in touch with each university or school where one or more fellowships were maintained so as to afford direct personal naval contact with the work undertaken.

It is possible that the navy might find it desirable to assign, at times, naval officers to university laboratories to work, either independently or in conjunction with members of a research reserve, on special problems. All the large industrial companies have learned by experience that every cent they have spent on research has been returned to them many times over in improvement to their product. It is certain that every cent the navy may spend in fostering this proposed naval research reserve will be the most profitable expenditure made in its efforts to be ready for emergencies.

I am presenting this as an individual naval officer's views. The subject seems to me to be of great importance, and I feel that some such plan as outlined should be actively developed at once. This will require the active support of scientific societies and organizations, as well as that of naval officers.

C. S. McDOWELL

U. S. NAVY

### SOME NEW FUNDAMENTALS IN PLANT BIOLOGY, AGRICULTURE AND THE FOOD PROBLEM

THE discovery that plants obey a logarithmic law of increase under the action of growth factors was announced by Eilhard Alfred Mitscherlich (Koenigsberg) in 1909. During the twenty years that have now intervened numerous investigators have tested this law both by laboratory experiments and by extensive field experiment and observation in various quarters of the globe. The earlier doubts and criticisms have been swept aside by an immense mass and variety of confirmatory data, and although the voice of skepticism has not been wholly silenced, it may be stated that the opposition has become practically negligible.<sup>1</sup>

It is not too much to characterize the work of Mitscherlich as by far the most important contribution that has been made to agricultural science since Liebig discovered the rôle played by mineral plant

<sup>1</sup> The historical development of the Mitscherlich laws of plant growth is traced mainly in the files of the *Landwirtschaftliche-Jahrbuecher*, the *Landwirtschaftliche-Versuchsstationen* and the *Zeitschrift fuer Pflanzenernaehrung und Duengung*. Readers desiring a condensed view of these laws and their experimental foundations may consult Mitscherlich's "Die Bestimmung des Duengerbedurfnisses des Bodens" (Paul Parey, Berlin). The same logarithmic law of growth was independently discovered by Spillman several years after Mitscherlich. Spillman's book "The Law of Diminishing Returns" (World Book Co., Yonkers, N. Y.) also contains a fair—although now somewhat obsolete—summary of the earlier stages of the development of these laws and the controversies they aroused. A short monograph dealing with the present-day scientific, social and economic implications of Mitscherlich's epochal discovery is in preparation by the writer.

food in the nutrition of vegetable organisms. But Liebig left an unfinished work which none of his immediate followers was able to complete; Mitscherlich has now put the capstone on the structure whose foundations were laid by Liebig and has given to agriculture new fundamental laws of vitalizing clarity. The gift has not been to agriculture alone; the biologist and especially the plant physiologist, the geneticist, the sociologist and the politico-economist may find in it new problems and new view-points of transcendent interest and importance.

The Mitscherlich laws are two in number but they really fuse into one which is mathematically represented by the equation  $\frac{dy}{dx} = (A - y) \cdot c$ , in which  $y$

is the increment of yield due to an increment  $x$  of a growth factor that has been placed at the disposal of the plant,  $A$  is the maximum yield which this growth factor is capable of producing when its amount is increased to the point where additional amounts thereof are without further effect and  $c$  is a constant which is characteristic of the growth factor. When integrated and transformed this equation becomes

$$\log (A - y) = \log A - c \cdot x.$$

Mitscherlich and those who have followed in his footsteps have sufficiently proved that this equation applies to the yield of any plant growing under the influence of a given growth factor, and appropriate forms of the equation have been derived that represent the action of two or more growth factors in combination. It has also been sufficiently proved that every growth factor has a definite and invariable effect factor or constant,  $c$ ; or, as worded by Mitscherlich: "Within every growth factor there resides a perfectly definite effect factor that is the same under all circumstances whether of soil, of climate, or of cultural conditions; it is even independent of the nature of the plant itself."<sup>2</sup>

This "effect law" of growth factors is the Magna Charta of a new agriculture by which the ancient art of the tiller of the soil may be given the dignity of a real, mathematically regulable science. There is here

<sup>2</sup> Now that experimental proof of the validity of the Mitscherlich law of effect factors has been abundantly forthcoming it may be seen that the constancy of their effect is a necessary consequence or deduction from two other great natural principles: the old law of diminishing yields from land and the law of the constancy of genotypes. According to the first of these principles the increment of yield from crop plants always diminishes even though steadily increasing increments of the factors of growth are supplied; according to the second principle vegetable organisms make definite and reproducible responses to given combinations of growth factors, i.e., vegetation experiments with a given strain are capable of exact replication. The existence of definite effect factors residing in growth factors is therefore a categorical necessity, and the action of these effect factors must come under a law of diminishing response.

no room to show how the growing of crops is thus lifted out of the empiricism that has enshrouded agriculture from the beginning; this brief note must be limited to a bald summary of the most important new concepts derived from Mitscherlich's epochal work.

(a) *The ultimate limit to the effect of a growth factor.* If in the equation  $\log (A - y) = \log A - c \cdot x$  we put  $A = 100$  (i.e., 100 per cent. of a maximum crop), if we give  $x$  successively increased numerical values, as 1, 2, 3, etc., and insert the known effect factor  $c$  pertaining to a given growth factor, we can calculate the percentage values assumed by  $y$  as  $x$  is indefinitely increased. It will be found that the curves of the values of  $y$  asymptotically approach a fixed line, so that when  $A = y = 100$  further increments of  $x$  do not produce further increases in yield. In other words, a point is reached where  $x$  is exerting its maximum effect. This point is determined by the magnitude of the effect factor  $c$ , which is an invariable constant. For the three most important mineral plant foods: nitrogen, phosphoric acid and potash,  $c$  is respectively 0.122, 0.60 and 0.93. By means of these factors (the mean values of which have been determined by extensive experiment) and the equation  $\log (A - y) = \log A - c \cdot x$  we find that in the limit the effective amounts of the growth factors nitrogen, phosphoric acid and potash are, respectively, about 25, 5 and 3.5 quintals per hectare of land surface.

One of the necessary consequences of the law of the effect of growth factors is that plant growth depends equally on the action of all growth factors. Thus, though a hectare of soil may be supplied with twenty-five quintals of nitrogen maximum growth will not be attained by the plants unless the soil contains the stated amounts of phosphoric acid and potash, as well as maximum amounts of all other growth factors.

(b) *The ultimate limit to plant growth.* Because twenty-five quintals of soil nitrogen is the maximum amount of this growth factor which can have any effect in stimulating plant growth in one growth cycle on one hectare of land surface, it necessarily follows that the amount of dry vegetable matter produced in one growth cycle on one hectare can in no case exceed that amount determined by the percentage content of nitrogen found in the dry tissues of the mature plant. Thus, if the percentage of nitrogen in the tissues of the dry plant is 1 per cent., then, if the crop were able to use all the soil nitrogen placed at its disposal, the yield of dry plant substance could in no case exceed that amount of which 25 is 1 per cent., which is 2,500 quintals per hectare.

However, the plants can not resorb all the twenty-five quintals of nitrogen, although these twenty-five

quintals must nevertheless be present in the soil if maximum growth is to be attained. When we examine the yield curve we see that as  $x$  increases lineally,  $y$  increases asymptotically. The rate of increase conforms to a remarkable rule discovered by Baule, who has proposed to consider as one unit of a growth factor that amount of it which will produce half of the maximum yield ( $A$ ). Two Baule units will produce, not 100 per cent. of the maximum crop, but only 75 per cent.; three Baule units will produce 87.5 per cent. of the maximum crop, four units 93.25 per cent., etc. The increment of yield produced by the  $(n+1)$ th unit is therefore always equal to half of the increment of yield produced by the  $n$ th unit; and naturally the consumption of the growth factor by the plant decreases *pari passu* with the decrease in the increment of yield. When this relation is evaluated mathematically from the experimental data we find about 3.6 quintals as the maximum amount of nitrogen which any species of plant can resorb from one hectare of land in one growth cycle. If the tissues of the plant in question contain an average of 1 per cent. of nitrogen the total yield of dry substance can by no possibility exceed 360 quintals per hectare (32, 120 pounds per acre).

Here we have an impassable barrier to extension of the growth power of vegetable organisms. The law of the effect of growth factors has been found to hold for all species of plants which trustworthy investigators have subjected to experiment; it has been found to hold with varieties not in existence when the law was discovered, and it will presumably hold for all new varieties created by the plant breeders or by natural processes of evolution. Why the maximum growth power of plants should thus turn out to be so distinctly a function of the unit area of land surface, and why this function should be basically the same for any and all species of plants are biological mysteries, the unraveling of which may be left to the plant physiologists, the geneticists, the experimental evolutionists, or whoever may best accomplish it.

(c) *The varying "calorific duty" of vegetable nitrogen.* The ultimate crop-yielding ability of a plant species is thus inversely proportional to its percentage nitrogen content; e.g., some of the common legumes whose percentage content of nitrogen exceeds 2 per cent. in the dry substance produce far less dry matter per hectare than the sugar-cane, whose percentage of nitrogen is less than 0.1 per cent. Though all plants react by equal *percentages* of yield increase to equal increments of nitrogen applied to the soil, yet these increments of yield may be and are widely different in absolute amounts, and it is thus evident that the nitrogen energized by one species of plant may be more active physiologically in compelling the photo-

synthesis of non-proteinous matter—cellulose, carbohydrates, fats, etc., than the same amount of nitrogen taken up by another species; the photosynthetic power of a vegetable organism being inversely proportional to its nitrogen content (photosynthetic power being in effect synonymous with growth power) we are entitled to speak of the "calorific duty" of nitrogen as a differential genotypic character of plant species.

Because no plant may resorb more than 3.6 quintals of soil nitrogen per hectare of land surface, what a given species of crop plant does with its allotment of nitrogen becomes a matter of high importance both now and especially in the practical plant genetics of the future, when plant breeders will be faced with the necessity of creating new strains capable of producing more and more food calories per unit area of cultivatable land. In the interest of a constantly increasing population on the earth it devolves on the geneticists and plant breeders to discover whether and how the calorific duty of the nitrogen of food plants may be enlarged.

(d) *The concepts: perultra plant, perultimate yield.* The same increment of a growth factor (e.g., nitrogen) always produces the same *percentage* increase in yield, no matter what the species of plant may be. But while the percentage yield increases are thus always identical the ultimate maximum crop ( $A$ ) on which this percentage is calculated may be and is different for different species. However, in no case can the maximum yield ( $A$ ) exceed the amount determined by the quotient of 3.6 divided by the percentage nitrogen content of the crop.

We can express this in another way that will perhaps be more immediately intelligible to those who are interested chiefly in the social and politico-economic aspects of the new agriculture. The soil nitrogen resorbed by crop plants is mostly transformed into protein (protoplasm); chemists determine the amount of protein contained in vegetable substances by multiplying their nitrogen contents by an appropriate factor, usually 6.25. If all the 3.6 quintals of nitrogen that may be resorbed by a crop growing on one hectare of land is transformed into protein, then the maximum amount of protein that can be produced on one hectare in one growth cycle is  $3.6 \times 6.25 = 22.5$  quintals, equivalent in American units in round figures to 2,000 pounds per acre. A crop plant the genotypic growth power of which is equal to the production of 2,000 pounds of protein per acre has attained the uttermost of ability to energize inorganic nitrogen. Such a plant may be called a *perultra* plant because it has arrived at the *ne plus ultra* of growth efficiency; it is then giving a *perultimate* yield which that plant can not exceed under any

of the ordinary circumstances now affecting the growth of plants. Corn (maize) is a plant which is known to have attained this limit in certain varieties. The total amount of nitrogen contained in a corn crop which has yielded at the rate of 225 bushels to the acre corresponds to about 2,000 pounds of protein. If the law of the effect of growth factors is a valid law of nature (as it has all the appearance of being) nobody need ever expect to produce a greater corn crop than this; per contra, the man who produces less is missing something of his privilege. On the other hand there are species of plants, as rye for example, the highest recorded yield of which is far beneath that which corresponds to the perultimate yield of protein; such plants may be called *subultra* plants, their organisms not having the metabolic energy required for reaching the perultra limit.

(e) *The concepts: perfertile soil, pressure of satiation.* The plant physiological difference between perultra and subultra plants lies in the different resistances which they offer to the growth-promoting stimulus of the same given amounts of growth factors. In a *perfertile soil* (i.e., a soil which contains all growth factors in maximum amounts) 25 quintals of nitrogen will produce a maximum crop of either corn or rye, but corn, being in some varieties a perultra plant, will resorb more of this nitrogen than the subultra rye; and this disproportion in resorption will persist as the amount of soil nitrogen is reduced below 25 quintals. At any content of soil nitrogen rye offers more resistance to the nutritive action of this growth factor; or, otherwise expressed, in soils that are less than perfertile it requires a greater concentration of soil nitrogen to force rye to nourish itself so that it will take up as much nitrogen as corn. To express this idea with technical conciseness we say that plants differ in their "satiation pressures" in respect of growth factors. Perultra plants always have the minimum satiation pressure, which in the case of nitrogen is represented numerically by the ratio of the maximum effective amount of soil nitrogen to the amount resorbed under the influence of this maximum amount, that is to say, by the expression  $\frac{25}{3.6} = 7$ . "It takes the whole power of the

25 quintals to drive the 3.6 quintals into the perultra organism"; the smaller the external pressure of the growth factor the smaller the amount of it which is resorbed. In the limit perultra plants always have the lowest satiation pressure, which means that the satiation pressures of subultra plants are always greater than 7, being the greater the more the subultra plant lacks of metabolic energy required to attain the perultra limit.

(f) *The goal of crop-plant breeding.* In the existence of perultra plants and the apparent possibility of converting subultra into perultra species there lies a circumstance of vast significance, and a golden opportunity for creative work in practical genetics and plant breeding. Heretofore plant breeders (creators of new strains) have been working in ignorance of the wide margin within which they may seek to create new varieties of high and higher yielding power. The law of the effect of growth factors draws back the veil and discloses the distant goal which the plant breeder may yet reach in the service of humanity. The law declares that nature permits and even invites the plant breeder to take subultra species and breed them up to the perultra limit. By accident rather than design this has been done in a few cases, as with corn and the sugar-cane, although the great majority of growers both of corn and sugar-cane are still cultivating inferior subultra strains of these two crop plants. The most solid achievement (though also an accident) in the life work of the late Luther Burbank was the creation of a strain of potato that is now achieving yields corresponding to about 80 per cent. of the calculated perultimate limit, which is about 1,330 bushels per acre. Perhaps the most interesting example of a subultra plant that is being lifted out of the subultra class by intelligent and persistent breeding is afforded by the sugar beet; since the year 1900 the genotypic growth power of this crop plant has been enlarged 250 per cent., and if the beet breeders maintain for another dozen years the same rate of progress as they have marked in the past six years they will have definitely graduated the sugar beet into the perultra class. How many of the existing species of subultra crop plants are capable of being thus evolved under the hand of man remains to be seen, but their number is surely not a few.

(g) *The limit ratio of population to area of cultivatable land.* The human organism must consume a certain daily minimum amount of protein. We now know the maximum amount of protein that can ever be (directly) produced on an acre of arable land; if we know the minimum amount of protein that will suffice to sustain an average person we can determine the maximum number of persons that can be directly nourished on the produce of one acre. If we know the number of acres available for growing crops in a given region we can calculate with an assurance of finality the limit density of population in that region for the case that only perultra plants are grown and that the *known* means of causing these efficient organisms to give perultimate yields are put into effect. The law of the effect of growth factors thus opens the way to a definitive clarification of the

Malthusian problem, in so far as this problem depends on the ability of the soil to produce food. How this great new law of nature bears on the question of when the earth will become saturated with population is more extensively discussed by the writer in another place.

(h) *A theory of the perultimate limit to plant growth.* The existence of a common perultimate limit to the effect of growth factors and to the growth power of all plants is a circumstance striking enough to warrant an attempt to picture the underlying reason. At the present time explanation can be little more than surmise and hypothesis, but certain facts are known which furnish hints.

One likely hypothesis is suggested by the work of Stoklasa, who has apparently found that the growth power of plants is increased (*i.e.*, their pressures of satiation lowered) by exposing them to radiations from low grade Joachimsthal ores. These radioactive materials evidently create a field of force or of influence about the growing plants which acts to intensify their vital activities. But Stoklasa's field may very well be regarded as a secondary or supplemental field superposed on an original primary field of the same general kind; this primary field may be supposed to be due to a particular category of radiations which reach the earth from outer space, or they may come from the interior of the earth itself. The facts of plant growth indicate that this primary field has a certain finite intensity and thus does not supply energy or stimulus beyond a certain limit, this limit determining the perultimate limit to the amount of active protoplasm which may be formed or activated in a unit of space, or, as we may now say, in a unit field of influence. When, however, the primary field is reinforced by congruent radiations, as appears to be the case in Stoklasa's experiments, the total strength of the field is increased and the original perultimate limit on growth power is correspondingly displaced.

So much for the suppositive prime factor in the limitation on plant growth; the mechanism of the action of this prime factor remains to be accounted for. Certain hints in this direction are found in the work of the Java sugar-cane breeders whose spectacular achievements have so greatly upset the contemporary sugar trade. When a superior new variety of sugar-cane is created by cross-breeding it is found that the individual cells of the more vigorous variety are larger than corresponding cells of the less vigorous strains from which the newcomer was derived (Bremer). This will explain the existence of differences in the satiation pressures of varieties of the same species which differ in growth powers, for obviously at equal osmotic pressures a certain num-

ber of large cells may contain a greater aggregate quantity of dissolved substances than the same number of small cells of the same kind, *i.e.*, the former are able to draw more extensively than the latter on a given supply of soil nutrients without increasing the normal concentration of their cell liquids. Satiation pressure is, therefore, to some extent at least, an inverse function of cell size. The same relative lowering of the satiation pressures of the more productive new varieties would also occur if the size of the cells remained the same but their number increased relatively to the number of cells in the less productive; or increases in both number and size of cells might occur simultaneously.

The Java cane breeders have also noted that valuable new varieties are obtained from combinations which result in certain definite changes in the number of the chromosomes of the new variety. Growth power of varieties within a species is therefore also a function or an accompaniment of a particular sort of chromosome complex.

From these materials we may construct the following tentative hypothesis to account for the creation of more vigorously growing new varieties: The crossing of two different strains (particularly if the species is originally highly bastardized, like the sugar-cane) results in a certain new combination of chromosomes. There are reasons for supposing that chromosomes are intimately concerned in vital processes, and they may be supposed to constitute or to characterize a system which "tunes in" more or less accurately with the primary field or fields of influence which we have already supposed to supply the governing stimulus to plant growth. If the tuning in is perfect, then the size of the cells or their number, or both size and number, are adjusted to conform to the perultimate limit on growth, and the new variety is perultra. If the tuning in is imperfect, the full strength of the field can not be utilized and the new variety is subultra.

O. W. WILLCOX

RIDGEWOOD, NEW JERSEY

## SCIENTIFIC EVENTS

### A BIOLOGICAL STUDY OF NERITIC WATERS IN THE GULF OF MAINE

OVER a period of more than ten years oceanological investigations have been carried on in the Gulf of Maine and adjacent waters by Dr. H. B. Bigelow and the combined results have been published in three comprehensive monographs. These excellent reports cover very well the adult fish fauna of the gulf and the general biological and physical conditions in the offshore waters.

There remains, however, the marginal region extending from the shore to a point where the immediate influence of the coast is lost and open ocean conditions appear. This shallow or neritic zone plays a most important part in the natural economy of the Gulf of Maine. It is in this area, where the fertility of the waters is increased by outwash from the land and the rivers, that some very important fishing grounds (particularly the herring) are located. To date the American portion of the region has never been investigated in a comprehensive manner and studies of the same nature as those carried on by Dr. Bigelow are badly needed to supplement his work.

Inasmuch as the conditions in different areas along the coast of the Gulf of Maine vary considerably structurally and in the amount of outwash from the land, there will be considerable variability physically, chemically and biologically. In order, therefore, to understand the various fishery problems of the region it will be necessary to determine, so far as possible, these conditions. It is proposed to start work this year in the area lying between Mount Desert and the Canadian border and enlist the cooperation of all available interested organizations. Later it is hoped that such combined support might result in an extensive survey of the whole gulf to continue over a period of years. Certainly the problem warrants such attention. The program this year will include Passamaquoddy Bay and the herring fishery grounds, the work being carried on jointly by the Mount Desert Island Biological Laboratory, the Buffalo Museum of Science and Brown University, with the cooperation of the U. S. Bureau of Fisheries and the Museum of Comparative Zoology of Harvard University.

It is proposed to start work about June 15 with a suitable boat covering the region between Mount Desert and Passamaquoddy Bay at least once and if possible twice during the summer. In addition, special work will be concentrated in areas found most desirable for study. General hydrographical observations (temperature and salinity), chemical analyses of the water (nitrates, phosphates, silicates, pH), qualitative and quantitative micro- and macroplankton analyses, distribution and abundance of larval and postlarval fish, food of young fish and general observations on fishery conditions—particularly the herring—will be made.

The preliminary work will be carried on this year by a relatively small staff of three men with the part-time assistance of Mrs. Fish (for identification of larval fish). The staff will consist of Dr. Charles J. Fish, plankton and general hydrography; Dr. H. W. Rakestraw, chemistry, and one scientific assistant for field work and part-time analysis of stomach contents of larval and postlarval fishes.

A supervising committee has been appointed consisting of Dr. H. B. Bigelow, Commissioner Henry O'Malley, of the U. S. Bureau of Fisheries, and representatives of the Mount Desert Island Biological Laboratory and the Buffalo Museum of Science, to work out details of the program for the present season and plans for future investigations.

Such a survey will have three objects in view: *First*, a determination of the physical, chemical and biological conditions in the neritic waters of the Gulf of Maine; *second*, general oceanography (lateral extension of the region covered by Dr. Bigelow to the coast line); *third*, immediate problems of the fishery.

#### WORK OF THE ROCKEFELLER FOUNDATION

A REVIEW of the work of the Rockefeller Foundation in 1928, written by its president, George E. Vincent, will be published in a few days. In addition to recounting the activities of the past year, the review tells of plans for extending the scope of the foundation's work under a new régime which went into effect at the beginning of the year 1929, and also summarizes briefly the achievements of the organization during the first sixteen years of its existence.

During 1928 the Rockefeller Foundation continued its regular program of activities consisting chiefly in (1) promoting the development of medical knowledge by aiding schools of medicine, nursing and hygiene in many parts of the world; (2) advancing the cause of public health by helping governments fight certain diseases and strengthen their local health services, and (3) carrying out an extensive fellowship program by which 800 men and women were enabled to pursue additional studies, chiefly in countries other than their own. In doing this work the foundation disbursed from income and capital \$21,690,738, of which \$12,000,000 constituted an endowment fund for the new China Medical Board, Incorporated.

During the year plans were completed for a reorganization embodying as its main features the merging of the Rockefeller Foundation and the Laura Spelman Rockefeller Memorial into a new corporation to be known as the Rockefeller Foundation, and the extension of the scope of the new foundation's activities to include work in the natural and social sciences and in the humanities. A China Medical Board with independent self-perpetuating trustees to receive the lands and buildings of the Peking Union Medical College together with an endowment fund and annual appropriations was also created.

Since May 22, 1913, the foundation has paid out from income and principal a total of \$144,189,400. The emphasis has been on the training of doctors, health officers and nurses, the creation or strengthen-

ing of institutions of medical or public-health education, the building up of official health organizations, the promotion of field research, the demonstration of new methods. The war called for exceptional aid to medical services, social work in army camps and emergency relief, notably for children. For these purposes \$22,000,000 was appropriated.

Temporary antihookworm campaigns in the United States and in many other countries have been broadened into permanent official rural-health organizations. Malaria has been studied more fully and methods of control worked out at home and abroad. Yellow fever has been forced to retreat from Mexico and Central America and from northern South America, until it is now found only in Brazil and West Africa. A wartime antituberculosis organization built up with foundation aid in France has been wholly taken over by the French and is being incorporated into a general public health service.

Various schools and institutes of public health have been created or extended with foundation funds. For the strengthening of influential medical schools in many parts of the world from London to Singapore, the foundation has expended about \$29,000,000. This does not include building, equipment and support of the Peking Union Medical College and aid to hospitals and the premedical sciences in China.

Up to December 31, 1928, fellowships had been granted to 3,187 representatives of fifty-eight countries at a total cost of \$4,908,743. The international significance of these fellowships may be inferred from the fact that 1,383 of the total fellows pursued their studies in countries other than their own.

#### GIFT TO NEW YORK UNIVERSITY MEDICAL SCHOOL

MR. GEORGE F. BAKER, of New York City, has given the sum of \$1,000,000 to New York University to promote the teaching of surgery. The gift will form an endowment to be known as the George David Stewart Endowment for Surgery, in honor of the friendship that has existed for many years between Mr. Baker and Dr. Stewart.

According to plans made by Dr. Stewart, all professors and instructors are to be on half-time, for by that procedure both practice and instruction are the gainers. The teaching staff will be increased materially. Men will be selected according to their ability to be teachers and surgeons. Those who are picked or who apply for service in the department will be asked to undertake a post-graduate course of three years, in which the various subjects embraced by surgery are taught. The instructional staff will rotate methodically among all the surgical and related services and thus will be able to round out their knowledge and ability.

In cooperation with Bellevue Hospital, New York University purposes to expand and develop its colleges of medicine and dentistry, and the Baker gift will permit the realization of the first steps of the plan. According to Chancellor Brown \$15,000,000 will be sought for these further objects.

1. A laboratories building presided over by Dr. William H. Park, whose scientific discoveries have done so much for the welfare of humanity.

In this building will be found the activities of the Harriman Fund, which have recently been allied with New York University; the manifold activities of Dr. Park himself, which at the present time are concerned mainly with the various aspects of pneumonia; researches into hay fever, asthma and other diseases of the allergic group; special studies of heart disease and rheumatic fever; in a word, researches into some of the most prevalent and difficult of diseases.

In addition, this building will provide the necessary laboratory facilities for research in various fields, physiology, pharmacology, histology, etc., as well as for undergraduate instruction.

2. A new building for administration offices and for lecture halls.

3. A private pavilion where members of the faculty of the medical school or other distinguished physicians and surgeons may care for their private patients.

4. A building for the dental college which, near by Bellevue, can work in conjunction both with this great city hospital and with the university's medical college.

#### THE INTERNATIONAL CORN BORER CONFERENCE

UNDER the patronage of the French Minister of Agriculture, the first International Corn Borer Conference was held at the Pasteur Institute of Paris on April 25, 26 and 27. The ministers of agriculture of Hungary, Yugoslavia and Roumania had sent personal representatives, and the government of Poland had appointed an official delegate.

The conference was opened by Dr. Emile Roux, director of the Pasteur Institute, and Dr. Tage Ellinger, director of research of the International Corn Borer Investigations of Chicago. The inspector-general of agriculture, M. Rabaté, welcomed the delegates on behalf of the French government. At the opening session addresses were delivered by Professor E. Roubaud, of the Pasteur Institute, on "Scientific Problems relating to the Corn Borer"; by Professor V. Vouk, of the University of Zagreb, on "The Policy of Scientific Corn Borer Investigations"; and by Dr. Miklos Siegescu, assistant-secretary in the Hungarian Ministry of Agriculture, on "The Administrative Aspects of the International Corn Borer Investigations."

The formal opening session was followed by scientific meetings under the chairmanship of Dr. Ellinger. The following scientific men participated: Professor

E. Roubaud, Professor Metalnikov, Mr. K. Toumanoff and Mr. V. Chorinee, of the Pasteur Institute; Director A. Paillot, of France; Professor H. Prell and Dr. H. Sachtleben, of Germany; Dr. A. Kemner, of Sweden; Professor A. Kotlan and Dr. Bela Husz, of Hungary; Professor Vale Vouk, of Yugoslavia, and Director W. Knechtel, of Roumania.

At the suggestion of the ministers of agriculture of Hungary, Yugoslavia and Roumania, a commission was formed to consider the formulation of uniform corn borer regulations in the three countries comprising the central European corn belt. Members of this commission are Dr. Tage Ellinger, chairman; Director Knechtel, of Roumania; Dr. Siegescu, of Hungary, and Professor Vouk, of Yugoslavia.

### THE TEXAS ACADEMY OF SCIENCE

THE Texas Academy of Science completed its reorganization during a meeting held at the University of Texas at Austin on May 24 and 25. The Texas Academy was first organized in 1892 and continued its meetings up to the time of the war. Its total membership was about five hundred, and twelve volumes of proceedings were published. A preliminary meeting for reorganization was held in San Antonio on November 29. The membership at the time of the present meeting is about seventy-five. A section in the newly adopted constitution incorporated the membership of the old academy into the new, thus making the total membership about one hundred and twenty-five. At the first session Dr. E. P. Schoch gave a concise history of the search after potash deposits in West Texas, and predicted what might be expected as a result of the findings. Dr. B. C. Tharp gave an illustrated lecture on the vegetation of Padre Island and the Gulf Coast country. At night the University of Texas gave a dinner in honor of the old and new academies. Dr. H. Y. Benedict, president of the university, presided. Dr. Frederick W. Simonds, senior professor of the university, spoke on the history of the old academy, telling of noted investigators who belonged to its membership, and of their work and publications. To illustrate his talk, he introduced Dr. R. T. Hill, of the U. S. Geological Survey, who was the honor guest at dinner, as an example of the membership. Dr. Simonds closed his talk by saying that the reorganized academy had an immense opportunity and a running start. There were about seventy-five present. At the business meeting on Saturday morning a tentative constitution was adopted. The first regular meeting was set for the last week in November. C. T. Reed, Kingsville Normal School, is president. H. B. Parks, Texas Agricultural Experiment Station, is secretary.

### SCIENTIFIC NOTES AND NEWS

DR. THEOBALD SMITH, who reaches the age of seventy years on July 31, retires from the directorship of the department of animal pathology of the Rockefeller Institute for Medical Research on June 30. Dr. Carl TenBroeck, now a member of the institute, has been appointed acting director in his place. Dr. Smith has held the directorship since July 1, 1914, at which time he transferred from Harvard University to the Rockefeller Institute. He will continue to carry on his scientific work at the Princeton laboratories of the institute.

DR. JOSEPH S. AMES, dean of the college faculty and for three years provost of the Johns Hopkins University and formerly professor of physics and director of the laboratory of physics, has been elected to succeed Dr. Frank J. Goodnow, who has been president since October, 1914, succeeding the late Dr. Ira S. Remsen. The resignation of Dr. Goodnow, given to the board in January, 1928, was accepted to take effect on July 1 next in agreement with his wishes. He will become president emeritus, continuing his connection with the university by conducting a course of lectures. Dr. Ames is chairman of the National Advisory Committee for Aeronautics, which has done much important research work on the scientific phases of aeronautics.

DR. HERMAN SCHNEIDER, since 1919 dean of the college of engineering and commerce of the University of Cincinnati, has been elected president of the university. Daniel Laurence, business manager, has been elected vice-president. Dr. Schneider has been acting president since the retirement of President Frederick Charles Hicks.

AT the commencement exercises of the Case School of Applied Science, the doctorate of engineering was conferred on Dr. Charles S. Howe, the retiring president, and on Dr. William Elgin Wickenden, president-elect, who gave the commencement address. Dr. Howe retires after having served the Case School for forty years, twenty-seven of these as president.

AT the recent commencement exercises at Columbia University, the honorary doctorate of science was conferred on George Emerson Brewer, surgeon, and William Hallock Park, physician and medical officer, both of New York City, and on Dr. Augustus Trowbridge, dean of the Princeton University Graduate School. The doctorate of science in pharmacy was conferred on Walter A. Bastedo, pharmacist, physician and medical author; Robert A. Hatcher, professor of pharmacology at Cornell Medical College; Charles F. Schleussner, pharmacist; Wilbur L. Scoville, chairman

of the National Formulary Revision Committee, and on Frederick J. Wulling, dean of the University of Minnesota School of Pharmacy.

ON the occasion of its fifty-seventh commencement, Swarthmore College conferred honorary degrees on Dr. William F. G. Swann, director of the Bartol Foundation of the Franklin Institute, and Dr. Howard McClenahan, secretary of Franklin Institute. Dr. McClenahan delivered the commencement address.

THE honorary degree of doctor of laws was conferred by the University of Arkansas on commencement day, June 3, on George W. Droke, who becomes emeritus professor of mathematics next year, and on Dr. Frank Vinsonhaler, dean of the school of medicine.

THE medal of the class of 1889, Columbia University, which is conferred every three years on the graduate of the school of mines, engineering, chemistry or architecture who distinguishes himself to the greatest extent, was awarded at a luncheon given during the commencement exercises to Dr. Irving Langmuir. The medal goes to Dr. Langmuir for "distinguished achievement in improving the incandescent electric light."

DR. GEORGE E. BURGESS, director of the Bureau of Standards, was reelected president of the National Conference on Weights and Measures at its recent meeting.

THE committee on scientific research of the American Medical Association has made a grant of \$750 to Dr. George R. Herrmann, associate professor of medicine in the Tulane Medical School, for the study of problems in circulation.

DR. B. YOUNGBLOOD, for seventeen years director of the Texas Experiment Station and for the past three years principal economist in the division of cotton marketing of the bureau of agricultural economics of the U. S. Department of Agriculture, has been appointed principal economist in the office of experiment stations. He will give his attention primarily to studying the status of research in this field, the nature of the complex problems presented and the organization of definite projects to advance their solution.

DR. A. G. BLACK, of the University of Minnesota, will become head of the department of agricultural economics in the Iowa State College, and chief of the agricultural economics section of the experiment station on July 1, succeeding Dr. C. L. Holmes.

DR. JOHN LEE COULTER, president of the North Dakota Agricultural and Mechanical College at Fargo, North Dakota, who has specialized in rural economics, has been appointed chief economist of the

Tariff Commission. He succeeds to the post made vacant by Dr. Charles R. Turner, resigned.

RUDOLPH DIEFFENBACH will be the head of the new division of land acquisition which will come into being in the Bureau of Biological Survey on July 1. Mr. Dieffenbach has been a land-valuation engineer of the Biological Survey since 1925, and for thirteen years previously was with the Forest Service surveying and appraising lands for acquisition for forest purposes, classifying forest lands and relocating boundaries of forest lands.

DR. H. W. GILLETT, for many years chief of the division of metallurgy of the Bureau of Standards, has become editorial director of *Metals and Alloys*, a new monthly periodical published by the Chemical Catalog Company, Inc., by special arrangement with the Battelle Memorial Institute, Columbus, Ohio, of which Dr. Gillett becomes director on July 1. Dr. Gillett will be assisted by Mr. Richard Rimbach, of Pittsburgh.

RUSSEL H. ANDERSON, of the faculty of the University of Illinois, has been appointed to the curatorship of the division of agriculture in the Rosenwald Industrial Museum. Mr. Henry L. Johnson, of the Graphic Arts Company, Boston, will organize its division of printing and graphic arts.

RENÉ LERICHE, professor of surgery at Strasbourg, is visiting the United States primarily for the acceptance of an honorary degree from Harvard University at its commencement in June. He has been for two weeks director of surgery *pro tempore* at the Lakeside Hospital, Cleveland, Ohio, at the invitation of Professor Elliott C. Cutler. He will then visit the surgical clinics at Chicago, Rochester, Minnesota, St. Louis and Nashville, Tennessee. He was for the ten days before the Harvard commencement chief surgeon *pro tempore* at the Peter Bent Brigham Hospital, Boston, at the invitation of Professor Harvey Cushing.

DR. EDWARD H. HUME, executive vice-president of the New York Post-Graduate Medical School and Hospital, sailed for Great Britain on June 7 to spend several weeks studying post-graduate medical education in London, Edinburgh and Dublin.

DR. VILHJALMUR STEFANSSON has returned to the United States from England after delivering seventeen lectures at Cambridge, five at Oxford, two at London University and a single lecture before the Royal Geographical Society of London, besides various addresses before Chambers of Commerce and similar gatherings.

DR. S. A. WAKSMAN, microbiologist of the New Jersey Agricultural Experiment Station, left on May

22 to spend several months in Europe. He will attend the meetings of the Commission on Soil Chemistry of the International Society of Soil Science in Budapest from July 1 to 6 and will preside at the meetings of the Commission on Soil Microbiology of the society in Stockholm from July 25 to July 27. Numerous visits are contemplated at research laboratories on the continent.

DR. A. S. HITCHCOCK, principal botanist in charge of systematic agrostology of the U. S. Department of Agriculture, left New York on June 8 for London on his way to South Africa. He will attend, by invitation, the South African Association for the Advancement of Science, which is meeting in conjunction with the British Association at Cape Town and Pretoria and will give a paper on the "Relation of Grasses to Man." Dr. Hitchcock will visit Victoria Falls and then, by way of Beira, Portuguese East Africa, will go to Tanganyika and Kenya, where he will spend about a month collecting grasses on the tableland about Nairobi. He hopes to obtain temperate and alpine species on Mt. Kilimanjaro. The return to London will be through the Red Sea, with brief stops in Egypt and Palestine.

BILLS signed by Governor Franklin D. Roosevelt, of New York State, include a bill appropriating \$13,000 for the Geneva Experiment Station for research in certain insect pests. Another grants \$5,000 to the College of Home Economics for research on the living costs on farms. An appropriation of \$150,532 is made for new activities at the College of Agriculture, including investigations on the muck soil of the state, the production, storage and diseases of potatoes, problems involved in regional agricultural adjustment, the operation of city markets, cooperative marketing, aspects of rural government, and extension and development of the work in animal husbandry, including a new calf barn, extensive alterations in existing barns, larger maintenance funds and additions to the staff. The bill also carries \$10,000 for printing and a new editorial assistant. In addition to these special appropriations, the regular appropriation bills carried \$29,000, a fund for immediate needs, \$21,000 for general items in the College of Agriculture, \$7,950 for Home Economics, and \$26,260 for the Geneva Station.

At the annual meeting of the American Otological Society at Atlantic City on May 22 and 23, Professor Madison Bentley, of Cornell University, was the guest of the society and delivered an address on "The Psychologist's Interest in Hearing."

PROFESSOR CHARLES T. KNIPP, of the department of physics, of the University of Illinois, gave an illustrated lecture on "Cambridge University—The Caven-

dish Laboratory," on May 21, before Sigma Xi at Purdue University.

AMONG those who have accepted invitations to take part in the Sixth Annual Institute of the Norman Harris Memorial Foundation of the University of Chicago are Dr. Raymond Pearl, professor of biology and director of the Institute for Biological Research of the Johns Hopkins University; Dr. Charles B. Davenport, director of the Eugenics Laboratory, Cold Spring Harbor, New York; Dr. Warren S. Thompson, director of the Scripps Foundation for Population Research, and Dr. Louis I. Dublin, statistician of the Metropolitan Insurance Company.

WE learn from *Nature* that the Davy centenary celebrations at Penzance were planned for June 8, the arrangements having been made by the Royal Geological Society of Cornwall, the Royal Institution of Cornwall and the Royal Cornwall Polytechnic Society; the headquarters of which were, respectively, at Penzance, Truro and Falmouth. At noon on that day the Mayor of Penzance, accompanied by members of the Town Council and of the three Cornish societies, proceeded to the Davy statue, upon which a wreath was placed; luncheon was served at the pavilion, after which a public meeting was held in the same building over which the mayor presided. Addresses were given by Dr. J. Symons, president of the Royal Geological Society of Cornwall; Mr. J. C. Tregarthen, Sir Humphry Davy Rolleston and Sir Ambrose Fleming, the last of whom represented the Royal Institution of Great Britain, where for eleven years Davy worked and lectured. An exhibition of Davy relics was on view.

DR. LEIGH H. PENNINGTON, professor of forest botany at the New York State College of Forestry, Syracuse, died suddenly in Washington on April 23, at the age of fifty-one years. He was on sabbatical leave and had been employed by the government as expert forest pathologist on the study of the white pine blister rust. He had taught at the New York State College of Forestry for fourteen years.

DR. GEORGE SHARP RAYMER, associate professor of mining at Harvard University, died on June 3 at the age of seventy-three years.

GEORGE C. BRYANT, formerly expert on the crop reporting board of the U. S. Department of Agriculture, has died at the age of fifty-nine years.

APPROXIMATELY forty students and members of the faculty of Ball State Teachers College, Muncie, Ind., participated in the dedication of Dryer Memorial Hill and the Cairn of Remembrance, held at Pakagon State Park on Lake James, on May 25. The ceremonies were held in remembrance of Charles Redway

Dryer, late Indiana geographer, and were held in connection with the spring meeting of the Indiana Academy of Science. The Dryer Geography Club at the college, under the direction of Professor Frederick J. Breeze, head of the department of science, prepared the program, which included addresses by eminent scientific men of the state.

THE Swiss Naturforschende Gesellschaft will hold its one hundred and tenth annual meeting at Davos, from August 29 to September 1, under the presidency of Dr. W. Schibler.

At the annual congress of the Southeastern Union of Scientific Societies, which was held at Brighton, from June 5 to 8, Sir Arthur Keith gave his presidential address on "Southern Englishmen of the Pre-Roman and Roman Period."

THE fourteenth annual conference of the British Museums Association will be held at Worthing from July 1 to 5, under the presidency of Sir Henry Miers. The presidential address, on "Cooperation—the Association's Task," will be delivered on July 2, and will be open to discussion. In connection with the conference there will be an exhibition of museum furniture and requirements.

THE first assembly of the Pan-American Geographical and Historical Institute will convene at Mexico City in August, according to an announcement made recently at the Pan-American Union. The institute was created by resolution of the sixth International Conference of American States, which met at Havana in 1928, and by resolution of the Governing Board of Pan-American Union Mexico City was selected as the seat of the institute.

THE U. S. Civil Service Commission states that the positions of five senior chemists to direct chemical and technological research in the bureau of chemistry and soils of the Department of Agriculture are vacant and that in view of the importance of these positions in the field of chemical research and to insure the appointment of thoroughly qualified men for this work, an unusual method of competition will be followed to fill these vacancies. Instead of the usual form of civil service examination, the qualifications of candidates will be passed upon by a special board of examiners composed of W. W. Skinner, acting chief of the chemical and technological research unit of the bureau of chemistry and soils, Department of Agriculture; Percy H. Walker, chief of the paint and varnish section, Bureau of Standards, and A. S. Ernest, examiner of the U. S. Civil Service Commission, who will act as chairman of the committee. For the purposes of this examination all will be examiners of the Civil Service Commission. The work in three

of these positions is in connection with research in organic chemistry to ascertain the structure of complex organic compounds of high molecular weight naturally occurring in certain tropical plants and characterized by high toxicity to fish and insects. The work of the fourth senior chemist position is concerned with the direction of research in inorganic and physical chemistry with special reference to insecticides and fungicides. The fifth senior chemist will engage in investigations of the physical properties and chemical compositions of turpentines, rosins and other naval stores products. The entrance salaries are \$4,600 a year. Formal applications will be received by the commission until June 20.

THE medical fellowship board of the National Research Council, of which Dr. G. Carl Huber, professor of anatomy and dean of the graduate school of the University of Michigan, is the chairman, met on April 27 and made the following appointments for the year 1929-1930: *Reappointments*: Simon Dworkin, physiology; Stephen J. Maddock, experimental surgery; Kenneth I. Melville, pharmacology and physiology; Valy Menkin, physiology; David McK. Rioch, neurophysiology; Ethel D. Simpson, physiology. *New appointments*: Edgar V. Allen, internal medicine; Eric G. Ball, physiological chemistry; Claude H. Forkner, pathology and clinical investigation; Emidio L. Gaspari, bacteriology and immunology; Arthur K. Koff, obstetrics; Milton Levy, biochemistry; Ava J. McAmis, physiological chemistry; Leone McGregor, pathology; Charles Midlo, anatomy; Bruce Webster, internal medicine. The next meeting of the board will be held on September 14, and applications to receive consideration at that time should be filed on or before August 1.

THE South Dakota Academy of Science held its fifteenth annual meeting at Sioux Falls, S. D., on May 1 and 2. The afternoon of the first day was devoted to the reading of papers by members of the academy. A banquet was served to the members and guests at six o'clock followed by an address on "The Chemistry of Wheat," by Professor J. M. Blish, of the University of Nebraska. The forenoon of May 2 was also devoted to the reading of papers by the members, followed by a general discussion. The attendance was especially good, the various educational institutions of the state being well represented. The officers for the year 1929-30 are as follows: *President*, E. P. Rothrock, state geologist; *first vice-president*, J. H. Jensen, professor of chemistry, Northern State Normal; *second vice-president*, A. V. Lowery, professor of biology, Eastern State Normal, and *secretary-treasurer*, A. L. Haines, professor of chemistry at the State University.

THE Kansas Entomological Society, in conjunction with the Kansas Academy of Science, has held its fifth annual meeting. Eight entomological papers were presented, one being an illustrated talk on "Entomologists and Their Laboratories in Europe," by Dr. H. B. Hungerford, of Kansas University. The officers elected for the ensuing year are: Dr. H. B. Hungerford, department of entomology, University of Kansas, *president*; Mr. J. R. Horton, Bureau of Entomology, Wichita, Kansas, *vice-president*; Dr. R. L. Parker, Kansas State Agricultural College, *secretary-treasurer*. Dr. Parker was also elected a member of the executive council of the Kansas Academy of Science, representing the Kansas Entomological Society. The publication of the *Journal of the Kansas Entomological Society* is in its second volume, and is publishing entomological papers of the region between the Mississippi Valley and the Rocky Mountain region.

THE agricultural colleges of eight southwestern states are organizing to solve erosion problems and at a meeting at College Station, Texas, on June 20 and 21, will invite farmers, farm editors, railroad officials, bankers, representatives of fertilizer companies and millers to assist the extension and research workers of the states in planning an erosion-prevention program which will be coordinate with the national program approved by Congress.

SAMUEL S. FELS, the soap manufacturer, will give a planetarium to the Franklin Institute at Philadelphia.

THE commission provided for under the migratory bird conservation act passed by the last session of Congress includes three members of the President's Cabinet, who serve *ex officio*, and include the Secretary of Agriculture, who is chairman of the commission, the Secretary of Commerce and the Secretary of the Interior. In addition, two members of the Senate and two members of the House of Representatives are made members of the commission to be named by the Vice-President and the Speaker of the House. The two Senators appointed are Peter Norbeck, South Dakota, who was the author of the Senate migratory bird refuge bill, and Senator Harry Hawes, of Missouri. The House members appointed are Congressman Ernest R. Ackerman, of New Jersey, and Congressman Sam McReynolds, of Tennessee, says a bulletin of the American Game Protective Association. The duty of this commission is to pass upon the purchase of lands selected by the Bureau of Biological Survey as suitable for migratory bird refuges. It is anticipated that two or more such refuges will be selected for each state, due consideration being given to the areas frequented by the birds for wintering and routes taken by them in their migratory flight.

The migratory bird act provides for the expenditure of an appropriation of more than \$7,000,000 to be expended over a period of ten years.

THE *Experiment Station Record* reports that the union of the Federal Experiment Station with the Hawaii University Station is provided in a joint agreement recently effected by the U. S. Department of Agriculture and the university. The combined station will be known as the Hawaii Experiment Station and will have as its director John M. Westgate, the present director of the federal station. The research staff will include all former members of the staff of that station and in addition a number of specialists from the university faculty.

### UNIVERSITY AND EDUCATIONAL NOTES

By the will of the late Frank L. Hall, of Kansas City, De Pauw University will receive the residue of his estate said to be of the value of at least \$750,000.

GIFTS have been made for the proposed internal reconstruction of the medical buildings of the University of Edinburgh of £20,000 from the trustees of the late Sir William Dunn and £35,000 from the Rockefeller Foundation.

SIR THOMAS HENRY HOLLAND, rector of the Imperial College of Science and Technology, London, has been appointed principal of the University of Edinburgh in succession to Sir Alfred Ewing. Sir Thomas, who is a Canadian by birth and sixty-one years of age, was formerly professor of geology and mineralogy at Manchester. Sir Robert Falconer, president of the University of Toronto, had declined an offer of the principalship at Edinburgh.

DR. HAROLD R. PHALEN, professor of mathematics and instructor in physics at St. Stephen's College, Columbia University, has been appointed dean of the college.

DR. K. LARK-HOROVITZ has been promoted to be director of the physics research laboratory at Purdue University.

DR. HENRY M. WINANS, of Dallas, Texas, has been appointed professor and chairman of the department of medicine at Baylor University College of Medicine.

DR. DAVID S. PANKRATZ, who is completing his work for the doctorate of philosophy in the department of anatomy of the University of Kansas this spring, has been appointed assistant professor of anatomy in the college of medicine of the University of Tennessee at Memphis.

DR. FRITZ PANETH, professor of chemistry at the University of Berlin, has been called to Königsberg.

## DISCUSSION

## GLACIAL GEOLOGY AND THE VERMONT FLOOD

AMONG the many interesting things connected with the Vermont flood of November, 1927, there is one of considerable interest to glacial geologists which I think has not yet been reported.

A quarter of a mile southeast of the East Clarendon station, on the Bellows Falls and Boston line of the Rutland Railroad, seven miles south of Rutland, Vermont, Mill River, one of the chief eastern tributaries of Otter Creek which drains the Rutland valley north into Lake Champlain, turns sharply southwest, almost at right angles from its comparatively open, terraced, northwesterly trending, glacial valley, and cuts a flume-like, box-canyon gorge fifty or more feet deep and an eighth of a mile long through gneisses, schists and quartzite of Whittle's Mendon-Algonkian series. A mile or two farther downstream, it cuts another similar and lower gorge and, having thus accomplished the steep side descent, flows out onto the broad floor of the glaciated valley of Otter Creek.

Passers-by on the railroad and state highway, as well as hikers on the Long Trail of the Green Mountain Club along the western range of the Green Mountains, frequently note the upper gorge, which is in plain view from railway, highway and Long Trail footpath and is a striking scenic detail.

As seen from the railway and highway, it opens with startling abruptness, like a narrow side passage-way straight to the southwest, out of the moraine-blocked, northwesterly trending valley of Mill River. Across the upper end of the gorge, like the lintel of a doorway, hangs an old-fashioned, board-sided bridge formerly crossed by the Green Mountain Club Long Trail, but now threatening to fall, and focusing attention on the mouth of the gorge.

Of the many who notice the gorge, some few of a more inquiring turn of mind wonder why Mill River makes such an abrupt turn here from a shorter, more direct course to a narrow and difficult one. The answer to these inquirers is that, at the time Mill River assumed its gorge course, it had no other choice. Its direct course to the northwest was blocked by the Lake Champlain-Otter Creek valley glacier and its deposits, of which the lateral kame-and-delta terraced moraine is still very conspicuous and fifty or more feet high at East Clarendon. Somewhat less conspicuous terrace deposits, some at much greater elevations, appear here and there along Mill River valley also.

The valley glaciers and their flanking morainal deposits, especially thick near the junction of Mill River valley with Otter Creek valley, spread across Mill River valley at East Clarendon, forcing Mill River to turn from its well-established, northwesterly

course, southwest along the Otter Creek moraine and glacier onto the gneisses and schists.

Once on them, Mill River began cutting into them, and it cut so long and so deep that, when the glacier blocking its former course melted out and the morainal deposits slumped or were partly washed away, it could not return to its preglacial course. Possibly in late glacial time Otter Creek drained southward to or toward the Hudson River. The sharp southwest turn of its branch, Mill River, on nearing Otter Creek valley, would seem a natural consequence. When northward drainage was finally established in Otter Creek valley, Mill River was too deeply entrenched in its gorges to avail itself of a more direct course. So it happens that the easier, earlier, northwesterly course of Mill River at East Clarendon is marked by a shallow pass, between the lateral delta moraine terrace and the gneiss ridges, and followed by the railway and state highway but not by Mill River itself.

The East Clarendon gorge is only one of many reported instances of postglacial gorges cut by glacier-displaced streams not only in Vermont but generally where much glacial deposition has succeeded stream dissection. Ausable Chasm, across Lake Champlain, in northeastern New York, and the famous gorge of the Niagara River are classic examples.

Mill River, like all streams flowing from the Green Mountains, became a rushing torrent during the November, 1927, flood. It swept away both heavy iron state highway bridges at Cuttingsville, three miles upstream from East Clarendon, bending iron rods like pins. It frequently changed its course, converting long stretches of highway into river bottom, cutting through meadow and woodland, excavating moraine and terrace and leaving former bends and pools deserted. The erosive work of a single night and day was astounding. Five miles of state highway were so demolished that it will require most of the coming summer, in addition to last year's work, to complete repairs. It furnishes a most impressive example of the rapidity and intensity with which a stream occasionally works, and helps the mind to visualize more dramatically the earlier cutting of the glacial terraces.

At East Clarendon, where Mill River turns at right angles from its open preglacial course to enter its narrow gorge, the constricted torrent rose twenty feet and flowed over the north end of the old wooden bridge spanning the mouth of the gorge. The rough stone foundation of the other end was partly swept away, leaving the bridge hanging precariously on a slant. Débris, on the sides of the gorge and in trees and thickets, still marked a year afterward the height reached by the rising water.

Erosion was enormously intensified, according to well-known laws, and concentrated upon the outer side

of the abrupt turn from the comparatively open course into the gorge; that is, it was concentrated upon the railroad embankment and morainal deposits blocking the preglacial former course of the river. In other words, Mill River set to work to regain its former course now occupied by moraine, state highway and Rutland Railroad. Only the abatement of the storm prevented the river, after washing away the railroad embankment, from cutting through the moraine and down into the village of East Clarendon.

Conditions developed somewhat suggestive of those at the famous Whirlpool in the gorge of the Niagara River, but of course on a very much smaller scale. Niagara River, at the Whirlpool, runs athwart the moraine-filled course of an older, preglacial stream, and has scoured out of the moraine-filling a vast pit about which it whirls in an effort to find the narrow gorge gateway out, at a considerable angle to that by which it entered. So Mill River, flooded to torrent strength, rushed straight for the pass in its moraine-filled former course at East Clarendon, whirled against railway, highway and moraine embankment, and roared out under the old bridge and through the narrow gorge in the gneiss series.

The through train for Boston reached East Clarendon late that afternoon and started through the pass in the moraine and onto the railway embankment against which the whirl of Mill River was directed. Passengers reported that they felt the embankment yield under the weight of the train and the attack of the river, but the train pushed on in safety to Cuttingsville, where it was stalled for several days. The embankment over which it had passed at East Clarendon soon slumped into the river, and a half dozen freight cars and carload upon carload of marble refuse from the yards of the Vermont Marble Company at West Rutland and Proctor were required to fill the gap.

What might have happened to the village of East Clarendon had the storm continued and Mill River cut through the pass in the moraine is suggested by what actually did happen at Proctor about the same distance beyond Rutland. There, Otter Creek, or another branch stream, too swollen to pass through its gorge, overflowed, cut across the Vermont Marble Company yard, submerged a milk train stalled in a railroad cut and washed away a large part of the farmland slope leading to its lower valley.

CUTTINGSVILLE, VERMONT JULIUS W. EGGLESTON

#### THE SPECIES OF PARAMECIUM AND THE THYROID QUESTION

A RECENT article by D. H. Wenrich (*Trans. Am. Mic. Soc.*, 47: 275: 1928) discussing eight well-defined species of *Paramecium* calls attention to the

fact that these species differ not only morphologically but also physiologically, and points out the importance of proper species determination in experimental research. These conclusions are of particular interest to me in view of my contributions (*J. Exp. Zool.*, 17: 297: 1914, and 22: 529: 1917) regarding the effects of a thyroid diet on *Paramecium*, in which I concluded that this protozoon could ingest thyroid substance with a pronounced acceleration of the division rate. The species studied were then described as *P. aurelia* (1914) and *P. caudatum* (1917). With regard to the second species I reported the effect of thyroid on the structure and activities of the contractile vacuole, and described the appearance of individuals with three contractile vacuoles in the thyroid-treated lines. At about the same time Hance (*J. Exp. Zool.*, 23: 287: 1917) reported the appearance of these multi-vacuolated individuals in a race described as *P. caudatum* after subjection to high temperatures. Subsequently Landis (*J. Morph. and Physiol.*, 40: 111: 1925) demonstrated that the species with which Hance worked was *P. multimicronucleata*, and that this race has a tendency to form three or more contractile vacuoles. I have recently restudied the preserved specimens of the races with which my own experimental work was performed and find that the 1914 race was indeed *P. aurelia* as described at the time, but that the 1917 race was *P. multimicronucleata* and not *P. caudatum*.

In view of these facts I have taken occasion to review the literature on thyroid feeding as applied to *Paramecium* with particular reference to the species involved and find that the results may be summarized as follows:

Nowikoff (*Arch. Protistenk.*, 11: 309: 1908) reports an increase in the division rate. *P. caudatum*.

Shumway (*l. c.*, 1914), an increase in the division rate. *P. aurelia*.

Budington and Harvey (*Biol. Bull.*, 28: 304: 1915), an increase in the division rate. *P. caudatum*.

Shumway (*l. c.*, 1917), an increase in the division rate. *P. multimicronucleata*.

Abderhalden and Schiffman (*Pflüger's Arch.*, 194: 211: 1922), an increase in the division rate. *P. sp.* (?)

Cori (*Am. J. Physiol.*, 65: 295: 1923), an increase in the division rate. *P. putrinum*.

Woodruff and Swingle (*idem*, 69: 21: 1924), no increase in division rate. *P. aurelia*.

Torrey, Riddle and Brodie (*J. Gen. Physiol.*, 7: 449: 1925), an increase in the division rate. *P. sp.* (?)

The three last contributions also report that thyroxin does not increase the division rate as I can confirm from unpublished researches. It is, however, significant that thyroxin is active only in an alkaline medium, while the normal environment of *Paramecium*

is slightly acid. So far this particular difficulty has not been overcome, and the effect of thyroxin on the vital activities of *Paramecium* remains uncertain. It is to be hoped that future workers in the field will identify the species with which they work, and that this note will serve to correct an erroneous identification by the writer.

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### THE SMELT IN LAKE MICHIGAN<sup>1</sup>

ATTENTION has been called to the fact that the smelt (*Osmerus mordax*) originally introduced in 1912 into Crystal Lake, Michigan, from Green Lake, Maine, has spread to Lake Michigan.<sup>2</sup> The first specimen came from off Frankfort in 1925, and others have been identified since, coming from Big Bay de Noc, Delta County, and Charlevoix, Michigan. Increase in numbers has been noted each year and unverified reports of its capture have come from other North Michigan ports as far as the Straits of Mackinac.

The first specimen collected from Lake Michigan had a stomach content consisting of a young specimen of the Lake-herring (or of some other species of the whitefish family) and crustaceans (*Mysis oculata*), which caused some apprehension since the smelt in the shallow waters (12-20 ft.) of Crystal Lake eat large numbers of small fishes, mostly *Notropis atherinoides*.

This was enhanced by the writer's discovery that the yearling smelt from Howe Lake (Lake Superior watershed) were at this small size feeding almost entirely upon their own young and the young of perch (*Perca flavescens*).<sup>3</sup>

In the spring of 1928 ten smelt were collected from Lake Michigan from water twenty to twenty-five fathoms deep off Empire, Michigan. They were mouthed in the large-meshed gill nets of the commercial fishermen which were taking nearly all whitefish and a very few lake trout. Their stomachs were entirely filled with *Mysis oculata*. The fact that the smelt can exist upon such a diet when in deep water further emphasizes the fact that this fish can range throughout the Great Lakes and seems destined to become one of the most abundant fishes of these lakes. In the deeper waters of Crystal Lake the smelt likewise feeds mostly upon *Pontoporeia affinis* and *Mysis oculata* in contrast to its extensive fish diet in the

shallow water. The smelt is therefore an enemy of all smaller fishes, including the young of the commercial species, as well as a competitor for the food of the adults of the larger species. The abundance of food, however, renders this competition less important.

A study of the growth of these smelt as determined from their scales after the standard method<sup>4</sup> and based on an unpublished fish-length, scale-length curve computed from a large series of smelt from Crystal Lake gave these average lengths: 88.7 mm for the first year; 149.3 mm for the second year, and 168 mm for the third year. Crystal Lake smelt averaged 92 mm in length for the first year; 156.9 mm for the second, and 171 mm for the third. Nine of the specimens were three years old and one two years old.

The three-year-old fishes were the most abundant size collected in the spawning run at Crystal Lake in 1923 according to the final determination, rather than the two-year-old size as preliminarily reported.

It is to be regretted that the smelt has become inexorably established in waters where it can not be limited or controlled. There is little chance to utilize it commercially except at the developed spring spawning runs and with ice lines in a few favorable locations. Gill nets of small mesh are impracticable because of their capture of a large number of immature commercial fishes.

This establishment of the smelt is another instance emphasizing the need for very close control of all experiments in the introduction of any kind of animal into a new location. Even with a very thorough knowledge of the life-history of a fish in its native waters little can be predicted as to the place it will assume in the readjustment to the new environment. Careful control, therefore, during such experiments is an imperative matter.

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### QUOTATIONS

#### HUMPHRY DAVY

SIR HUMPHRY DAVY, who died one hundred years ago, was one of three men—Thomas Young and Michael Faraday being the other two—who by sheer force of native intuition made the Royal Institution, and with it this country, an unsurpassed center of scientific light and leading in the earlier part of last century. He was little more than a boy when he was drawing crowds to hear his lectures and witness his experiments. Before he was thirty he had won a European reputation by investigations which give him

<sup>4</sup> C. W. Creaser, "The Structure and Growth of the Scales of Fishes, etc.," Univ. of Mich., Museum Miscellaneous Pub., No. 17, 1926.

<sup>1</sup> Contribution from the University of Michigan Biological Station and the College of the City of Detroit.

<sup>2</sup> C. W. Creaser, "The Establishment of the Atlantic Smelt in the Upper Waters of the Great Lakes," Paper Mich. Acad. Sci. V.: 405-424, 1925.

<sup>3</sup> C. W. Creaser, "The Food of Yearling Smelt," Paper Mich. Acad. Sci. VIII, 1928.

a permanent place among the great chemists of the world. He was only fifty when he died, but bad health, and perhaps it must be added marriage and a fortune, marred his latter years, and if he had not lived beyond forty his fame would have stood as high as it does. When he began his work chemistry was entering on a new era. It had all but cut itself free from the doctrine of phlogiston, that mysterious principle of fire, sometimes ponderable, sometimes imponderable, and sometimes even possessed of negative weight, which had dominated it for more than a hundred years. Lavoisier had shown that in the explanation of combustion and kindred processes the final appeal must be to the balance, and gradual progress had been made towards establishing the conception of the chemical elements that still holds, even though the atom is no longer regarded as the ultimate unit of matter, and has become itself a complex microcosm of electrons whirling round a still more complex central nucleus. With the invention of the voltaic battery a new and potent instrument of research was put into the hands of experimenters, and Davy seized eagerly upon the possibilities it offered. Using it to direct chemical theory into fresh and unexplored channels, he not only demonstrated the compound character of many substances which previously had been accepted as elementary, but also forged a link between chemical and physical phenomena, and thus entitled himself to rank as a pioneer of the electric theory of matter.

If a certain impetuosity of temperament, coupled with an ambitious desire for "the honorable meed of the applause of enlightened men," sometimes betrayed his flashing intellect into the hasty publication of insufficiently verified hypotheses which the steady glow of Faraday's genius would have avoided, he always had an exalted view of the dignity and the importance of science no less in its utilitarian than in its moral and intellectual aspects. He realized that, in his own words, the prosperity and the riches of a country are intimately connected with the progress of the arts and sciences, and that no people has attained any considerable degree of civilization independent of the chemical arts, and—taking science as *illustrans commodam vitam*, in the Lucretian phrase which serves as the motto of the Royal Institution where most of his work was done—he could turn to the study of the practice of tanning, the application of chemistry to agriculture, or the construction of a safety lamp for miners, with as much zeal and enthusiasm as he displayed in the abstract inquiries of the laboratory. Some of his contemporaries held a high opinion of his capacity as a poet, but time has not endorsed their judgment. The poetic and imaginative quality of some of his prose writings may be admitted, but his

excursions into verse are forgotten, and it is as a natural philosopher that his fame endures.—*The London Times*.

## SCIENTIFIC BOOKS

*The Nature of the Physical World.* By A. S. EDDINGTON. The Macmillan Company, New York, 1928. xvii + 361 pages, \$3.75.

THIS book contains substantially the course of Gifford Lectures delivered by Professor Eddington at the University of Edinburgh during the first three months of 1927. Intended for the general public, it is written in popular style without recourse to mathematical symbolization. Nevertheless in his aim to show how recent scientific developments have provided new material for the philosopher the author has not shirked the more recondite aspects of scientific discovery and the reader will find that the reasoning in many places demands his closest attention.

The subject-matter covers the great changes in our concept of nature that have taken place during the last twenty-five years, especial attention being paid to the relativity theory and to the new quantum dynamics of Heisenberg, Dirac and Schrödinger. As a pure exposition in non-mathematical language of these recent developments in physics Professor Eddington's book certainly has no equal in the English language. The author proves himself a marked exception to the rule that the scientist lacks the capacity to write entertainingly and in terms which are intelligible to the reader who is not a specialist. The seriousness of the argument is relieved by apt illustrations and the reader's chuckles are aroused by flashes of humor and striking epigrams. Nothing excited the reviewer's delight more than Professor Eddington's emendation of the first law of motion: "Every body continues in its state of rest or uniform motion in a straight line, except in so far as it doesn't."

The author's object, however, is far more than mere exposition. His real interest lies in the philosophical implications of modern physics and in the light thrown by scientific discoveries on such questions as the conflict between the ideas of free-will and predestination. After showing that science forms a closed cycle he investigates those values in human experience which lie outside the domain of the scientific method. The ripples on a moonlit lake conform in their scientific aspects to the equations of hydrodynamics, but the romance of the summer night can never be expressed by a differential equation. Even the scientist loves and sometimes hates. After all, science can not evaluate its own purposes. The motive force back of scientific investigation is something which transcends science itself.

The *motif* underlying the book is the passage from the mechanistic ideals of the latter half of the nineteenth century to the state where science looks for nothing more than mathematical formulation and realizes that even a description of microscopic phenomena in terms of concepts of space and time derived from macroscopic experiences may be unattainable. Science has discarded the services of the engineer and turned to the mathematician to construct its world. Instead of resorting to an ether whose particles have the properties of meshed gyrostats we have learned to be satisfied with abstract relata and relations. The rub to-day comes in the identification of the relata with the pointer-readings of the laboratory. The result has been that "the external world of physics has become a world of shadows. In removing our illusions we have removed the substance, for indeed we have seen that the substance is one of the greatest of our illusions. . . . The frank realization that physical science is concerned with a world of shadows is one of the most significant of recent advances. . . . From their [the physicists'] point of view it is not so much a withdrawal of untenable claims as an assertion of freedom for autonomous development."

While space is something quite external to the human consciousness, the author points out that time plays a dual rôle. In its external aspects it unites with space to form the four-dimensional continuum of Minkowski. But the sense of duration is one of which the mind is immediately conscious. The astonishing characteristic of time is its irreversibility. Classical dynamics—even the relativity theory—gives no reason why time should always advance forward and never backward. Professor Eddington thinks that the explanation of the one-way progression of time is to be sought in the statistical laws of nature such as the second law of thermodynamics. The time-arrow has the direction to make the entropy of the universe increase. These secondary laws of science are essential in order to determine the sense of its flow.

In spite of the fact that the author entertains little doubt that the universe is finite and closed after the manner of Einstein or De Sitter he adheres to the gloomy view that the mechanism is running down in accord with the demands of the second law of thermodynamics. He admits that this conclusion is incredible, but states that he can make no suggestion to evade the deadlock. May it not be, however, that in generalizing the statistical laws which apply to gas molecules to the cosmos he is paying insufficient attention to the difference in scale? A million million gas molecules may be in the condition which we call the state of equilibrium and may have occupied this

state for years, but if we examine a few hundred contiguous molecules for a millionth of a second it would not be at all surprising if we found that conditions among them were very far from the state of equilibrium during the whole of this brief interval of time. On the cosmic scale our observation of the stars is equally limited both in extent and in duration. To be sure, energy seems to become dissipated in space, but we are not without signs that the opposite effect may take place under appropriate conditions.

In his discussion of the wave mechanics Professor Eddington naturally stresses the abandonment of causality as well as causation in present concepts of atomic phenomena. Whereas the laws of classical physics are deterministic in form those of the new mechanics yield nothing more definite than measures of probability. But even in the classical era science made use of statistical relations in dealing with problems concerned with aggregates of particles such as are met with in the kinetic theory of gases. From the statistical point of view we calculate the probability of an assigned state of the gas and so obtain an estimate of the time during which the gas will find itself in that state. Here, however, we frankly admit that our use of the theory of probabilities is a cloak to conceal our incompetency to solve the problem by the deterministic methods of particle dynamics and to hide our inability even to state the initial conditions involved. The reviewer would like to think that the resort of physics to probability considerations in the atomic domain is a like confession of ignorance. Professor Eddington points out that while we can calculate the probability that an atom excited to the third quantum level may return to the second level and the probability that it may return to the first level, we can not predict which of these two events is the one which will occur. To the reviewer's mind, the fact that one and only one of the two possible transitions *does* occur makes it inconceivable that the choice of the transition is not related in some way—as yet unknown—to other events in the physical world. We are not demanding causation, which is arbitrary, but we still plead for causality. Indeed it hardly seems possible that science will ever find complete satisfaction in a formulation which makes the computation of probabilities its final achievement. The mind will refuse to discontinue the search for something deterministic beyond.

Heisenberg's principle of indetermination has introduced a new element into science. While this principle denies the possibility of predicting with exactness future microscopic events, Professor Eddington makes clear that it does not preclude an exact description of events after they have occurred. He feels that this principle provides the believer in free-will with

a loophole to escape the conclusions of the mechanistic philosophy of classical science. But have you or I any power of free choice? I turn either to the right or to the left—certainly I do not turn both ways at once. If you tell me that I can turn only to the right, I may refute you by turning to the left, but then your assertion has become a factor determining the direction which I take.

LEIGH PAGE

## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### PRACTICAL HINTS IN THE LABORATORY STUDIES OF PROTOZOA AND EARTHWORM

As far as the writer is aware no laboratory manuals have given the following time-saving devices for the studies of Protozoa and the earthworm.

#### PROTOZOA

In the study of Protozoa, ordinary cultures will show more free-swimming than sedentary forms. The latter are not difficult to study if a sufficiently high magnification is used, but the former are exceedingly hard to keep in the field. To try to keep track of the swimmers by moving the stage of the microscope is at best an unsatisfactory method. Students are prone to exclaim, "It is impossible to watch these wriggling beasts closely"; "I wish I could tie a string around one of them." The first statement is quite true; the wish is quite impossible.

Several methods have been suggested to reduce the difficulty: the use of cherry-tree gum, of potassium-

iodide or, as is highly recommended by some workers, quince-seed solution. The writer is much in favor of the less complicated lens-paper method which is more easily cleaned and shows the animals in comparatively more natural conditions. The lens-paper method: Lay a piece of lens paper (smaller than the cover glass) on a clean slide; place a drop of the infusion from the top of the culture; then place a thin cover slip over the top surface and the preparation is ready for examination. Some of the infusorians and other protozoans will be imprisoned between the fibers of the paper, but their usual activities and metabolism will continue.

There are several distinct advantages of this method:

(1) The animals are kept from active movements and can therefore be closely watched. (2) When a glass slip is dropped on small animals like Protozoa, it is very apt to crush them. In order that they may move about, means must be provided to support the

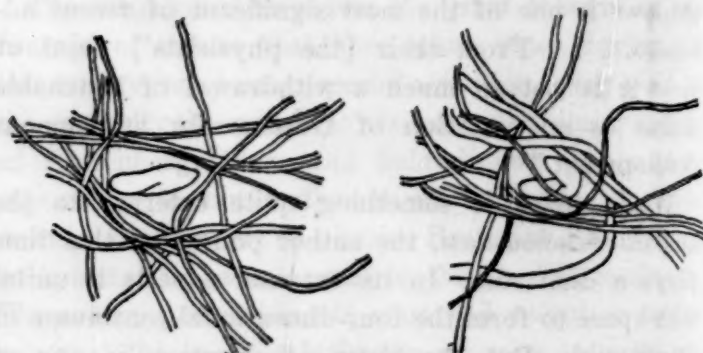


FIG. 2. Paramecia imprisoned between the fibers of lens paper.

slip at a short distance above the slide. Lens paper again fulfils the requirement and is less complicated than the making of a cement cell or the use of broken fragments of glass, as some workers suggest. (3) This method also serves well in the measurement of these protozoans. Measurement is necessary in the identification. (4) There is still another advantage. Some infusorians, Paramecium for example, will double and twist between the fibers, showing the flexibility of their bodies.

#### EARTHWORM

In the laboratory study of the earthworm much time is wasted in counting segments in order to figure out the positions of the different organs. This trouble can be much reduced if, after proceeding in the usual manner to cut the body wall along the median dorsal line, the pins are placed on the first, the fifth, the tenth and the fifteenth segments, etc. Thus there is a definite system of pinning and the number of segments can be counted by fives and some time is saved.

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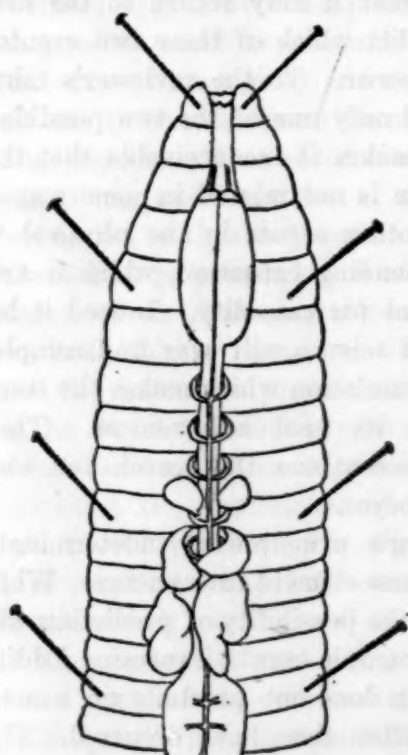


FIG. 1. One way of pinning the earthworm.

## SPECIAL ARTICLES

## THE PHOTOELECTRIC EFFECT AS RELATED TO THE SIZE AND SURFACE CONDITIONS OF CARBON PARTICLES

IN 1924 one of the authors tested the photoelectric effect of several dyes.<sup>1</sup> Films for the purpose were easily formed when using spirit soluble dyes. Experiencing considerable difficulty in preparing suitable films of certain other dyes, it was decided to try dusting or rubbing the dry powdered dye onto the test plates. The results proved quite satisfactory. Thinking that other powdered substances might be photoelectrically active, plates were prepared by holding them in the smoke from burning matches, from burning camphor gum, from a burning candle, from gas flame and from burning magnesium ribbon. Still other plates were prepared by rubbing onto them lamp black, powdered graphite from lead pencils, powdered chalk, etc. All these were active. However, those prepared by holding the plates in the smoke from burning substances were much more active, in some cases being very nearly as active as freshly polished zinc plate. This led to the conclusion that the activity of carbon was in some manner a function of its fineness.

In 1925 and 1926 the authors working at Michigan State College decided to test further the photoelectric effect of finely divided carbon. These investigations were carried on at atmospheric pressure. The apparatus consisted of a carbon arc as a source, an electrometer and a holder for the test-plates, all carefully shielded. The test-plates were of constant area, 5 x 6 cm. Solid carbon rods three eighths inch in diameter were used for the arc. A direct current was used and the source was kept constant by maintaining a constant voltage of forty volts across the arc. A highly polished plate of zinc, 5 x 6 cm, was used as a standard test-plate. In every case the plate was polished just before using.

Common black stovepipe iron was found to be inactive and it was selected for test-plates. However, it is inactive only when the coating due to the manufacturing process is on the plate. Since alcohol removed this coating the use of alcohol either as a cleaning agent or as a solvent for preparing films was discontinued. It is necessary to have an evenly distributed film or layer of the substance to be tested on the plate, and plates were so prepared by dusting the dry powdered substances onto them. The plate was

thoroughly cleaned, dried and tested before the powder was dusted onto it, and, if active, was cleaned again. If it still showed a trace of activity, it was discarded.

The following readings were taken: Scale reading before light was turned on, time in seconds for the electrometer to indicate a deflection of ten scale divisions, scale reading at the time the light was turned off, and the average voltage across the arc during this time. An average of one hundred readings taken with the standard zinc test-plate gave 5.0 seconds as the time for a ten scale division discharge. This was taken as a standard value, and all other values were compared with it.

The carbons in Table I differ in origin, degree of hardness and fineness, and are listed according to their sources. Thus a carbon listed as redwood is carbon obtained by partially burning redwood. Usually the carbon thus obtained was ground in an agate mortar, passed through a screen of known mesh and then dusted upon the test-plates. All excessive particles were removed by jarring the plate. In some cases the particles were brushed or rubbed onto the plate, using rice paper or absorbent cotton for the purpose.

TABLE I

Substance	Note	Time of discharge Sec.
Paraffin .....	(2)	9.2
Paraffin .....	(1)	8.3
Paraffin .....	(4)	not active
Camphor gum .....	(1)	26.6
Block of sulphur .....		not active
Piece of camphor gum .....		" "
Bone black .....		43.2
Poplar .....	(5)	26.5
Southern pine .....	(5)	23.8
Northern pine .....	(5)	23.1
Redwood .....	(8)	70.9
Redwood 100 .....	(7)	29.7
Redwood 80-100 .....	(7)	44.7
Redwood 60-80 .....	(7)	66.7
Redwood 40-60 .....	(7)	64.9
Redwood .....	(3)	30.9
Cypress .....	(5)	13.7
Arc carbon .....	(6)	19.3
Chestnut .....	(5)	17.7
Red-oak .....	(5)	16.5
Gum-wood .....	(5)	19.2
Black-walnut .....	(5)	19.0

## Notes:

- (1) Finely divided carbon, obtained from burning, brushed on plate with rice paper or absorbent cotton.
- (2) Finely divided carbon deposited on plate held eight inches above flame.

<sup>1</sup> The introductory part of this work was done in 1924 at Cornell University at the suggestion of Professor E. Merritt.

- (3) One week after being prepared.
- (4) Plate dipped in hot paraffin and cooled.
- (5) Carbon ground in agate mortar and passed through 100 mesh screen.
- (6) Collected at base of arc and brushed on the plate with rice paper.
- (7) 40-60 is carbon passed through a 40 mesh screen upon a 60 mesh screen.  
60-80 is carbon through a 60 mesh screen upon an 80 mesh screen.  
80-100 is carbon through an 80 mesh screen upon a 100 mesh screen.  
100 is carbon through a 100 mesh screen upon the pan below.
- (8) Ground in a porcelain mortar.

Carbon obtained from cypress, poplar, redwood, southern pine and northern pine is soft, having a flaky or needle-like structure as shown by photomicrographs. Table I shows that these are not as active as carbon obtained from paraffin, arc carbons, chestnut, red oak, black walnut and gum-wood, which is hard, having a distinctive granular structure. Because of the fact that soft carbon adheres to the test-plates much better than harder grades, more particles remain on the plate per square centimeter. Thus a greater photoelectric effect was expected; however, the reverse proved to be true. Therefore, the photoelectric effect increases with hardness of the particles.

Our results indicate that the photoelectric effect varies with the size of the carbon particles. Redwood (8) (Table I) was ground in a porcelain mortar, and it was coarse and flaky. It was quite inactive. Red-

wood (100) was more than twice as active as Redwood (40-60). Paraffin (1) having been brushed with rice paper was more active than paraffin (2), the coarser particles having been removed by brushing. Therefore we have some reason for believing that the photoelectric effect is modified by the fineness of the particles. However, it is possible that the apparent increase in the photoelectric effect with the decrease in the size of the particles is, at least in part, due to the fact that the effective area (the area normal to the direction of the incident light) increases with the fineness.

Further results obtained more recently appear in Table II.

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#### THE EFFECT UPON DIGITALIS PURPUREA OF RADIATION THROUGH SOLARIZED ULTRA-VIOLET-TRANSMITTING GLASS<sup>1</sup>

DURING the Nashville meeting in 1927, a report<sup>2</sup> was made by the writer concerning *Digitalis purpurea* plants which were started under glass that transmits ultra-violet light, and later grown in the open field. Such plants, when tested physiologically, proved to be considerably more potent medicinally than were the controls which had been exposed under ordinary glass.

The question at once arose as to whether such effects would continue to be obtainable after the glass had been solarized for several months; and the purpose of this brief paper is to give a report of work done upon this point.

During the season just passed, 1928, similar experiments were made, therefore, to serve as check tests on the previous findings. All methods closely paralleled those used in 1927, except that not so many plants were used as before. Each outdoor bed this year consisted of four rows of six plants each; and each group of twenty-four plants provided a composite sample.

While the plants were under greenhouse conditions, the difference between the treated plants and the controls was much less marked than in those of last year. Whatever advantage was observable, in size or color, lay constantly with the treated plants; but, when the plants were put out-of-doors, the two groups were practically identical to the eye. It was felt at

TABLE II

Substance	Condition	Time in sec.
Graphite as manufactured	Rough and uneven	13.4
Graphite plate cut out	Rough	9.3
Same plate	Polished on buffing wheel	4.7
Same plate	Roughened with No. 00 sand paper	8.5
Hard carbon	Very hard. Cut out with hacksaw and tested (surface covered with dust)	10.8
Same plate	Polished	8.6
Hard carbon plate held in flame from asbestos wick in liquid paraffin	Completely covered finely divided carbon	4.2
Zinc plate Av. of 25 readings	Polished	5.1+
Hard carbon plate	Covered with fine carborundum dust	not active

<sup>1</sup> Paper read before the Botanical Society of America, December 28, 1928, New York, N. Y.

<sup>2</sup> A. McCrea, SCIENCE, 67, No. 1732, 277-278, 1928.

that time that there would probably be a corresponding agreement in their activity.

Digitalis drug is harvested twice each season, the first cutting being in late July and early August, the second in September. These experimental samples were gathered at the same time and in the same manner as the field crop except that the writer personally picked and mixed the leaves rather than have the farm men do it.

After the leaves were carefully dried and milled, U. S. P. tinctures were prepared. These were then tested physiologically, by the M. L. D. frog-heart method.<sup>3</sup> Results are given in the table below, in reading which it should be borne in mind that U. S. P. standard tincture represents 100 per cent.

#### First Crop

Treated group .....	225 per cent. of Standard.
Control group .....	185 per cent. of Standard.
Increase of Potency, 21.62 per cent.	

#### Second Crop

Treated group .....	350 per cent. of Standard.
Control group .....	250 per cent. of Standard.
Increase of Potency, 40 per cent.	

It should be noted here that in Michigan we had a severe hailstorm last August 8, which rather badly injured the plants of the first crop. This probably explains the relatively low potency of that cutting. Spread out in its first-year, rosette form of growth, digitalis offers a fair mark for damage by hail. Many leaves were badly beaten and perforated in as many as ten places; so it is surprising that they gave as high activity as they did. Several of the plants died; but most of them revived, and showed no effects at the time of the second cutting.

Judged by the results of the past two summers, it appears quite conclusive (a) that digitalis develops a higher potency under the influence of ultra-violet-transmitting glass, and (b) that solarization for one year does not appreciably affect the transmission of the particular portion of such rays as are responsible for such effect in digitalis.

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### CHROMOSOME MORPHOLOGY IN *ZEAMAYS*

THE haploid number of chromosomes in *Zea mays* is ten. Several  $2n+1$  individuals (with twenty-one chromosomes) have arisen as the result of crosses between diploid and triploid individuals.<sup>1</sup> Since

there are ten known linkage groups, it is desirable to determine what linkage group is represented by the extra chromosome in the several  $2n+1$  individuals. Because of the desirability of associating each linkage group with a specific chromosome of the complement, a study has been undertaken to determine to what extent the different members of the complement are identifiable cytologically. Studies have been made of the first division in the microspore where only the haploid complement is present.

A semi-diagrammatic representation of the haploid set is given in Fig. 1. One chromosome possesses

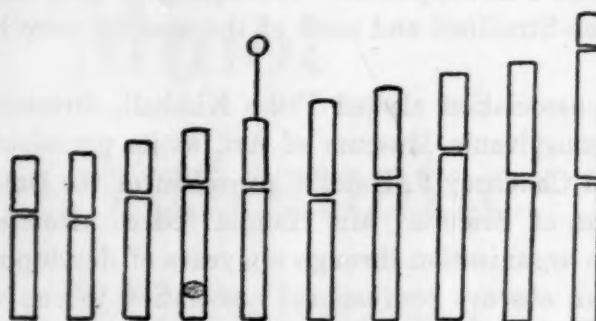


FIG. 1

a satellite.<sup>2</sup> During the prophase the satellite remains attached to the nucleolus until the latter disappears. The thread joining the satellite to the major part of the chromosome does not possess a constant relative length but varies in different figures. In the fourth from the smallest chromosome there is a deeply staining body which becomes very conspicuous during late prophase. Other chromosomes have less conspicuous bodies of this kind, but their exact position requires further study.

Besides the primary constrictions, with which spindle fiber attachment seems to be associated, there are secondary constrictions. Such a constriction is indicated near the end of the longest chromosome. The secondary constrictions, although always appearing in the same place in certain chromosomes, are not always evident in the observed figures.

Although only a preliminary study has been made, the author is convinced that every chromosome of the set is morphologically identifiable, differing from the others essentially as shown in the figure. It should be possible, therefore, after the extra chromosome in any  $2n+1$  individual has been associated with a certain linkage group, to determine from an examination of the eleven-chromosome microspores which chromosome of the haploid set carries this group of genes.

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<sup>2</sup> The satellite in *Zea* was first observed by L. F. Randolph.

<sup>3</sup> Houghton, E. M., *Jour. A. M. A.*, 31: 959, 1898.

<sup>1</sup> B. McClintock, *Genetics*, 14: 180-222.

## PHILADELPHIA MEETING OF THE AMERICAN ASSOCIATION OF MUSEUMS

THE American Association of Museums held its twenty-fourth annual meeting at Philadelphia, from May 22 to 24. The problems under discussion were those of science, history and industry museums, as well as those of art museums—which last the association considered in joint session with the American Federation of Arts. The two organizations brought their concurrent conventions to a close with a joint banquet attended by more than four hundred delegates and Philadelphians. Headquarters were at the Bellevue-Stratford and most of the sessions were held there.

The association elected Fiske Kimball, director of the Pennsylvania Museum of Art, as its president to succeed Chauncey J. Hamlin, president of the Buffalo Museum of Science. Mr. Hamlin retired after leading the organization through six years of development from an obscure professional association to one with well-established national headquarters—located in the Smithsonian Institution at Washington.

The meeting gave much attention to the plan of the new \$15,000,000 Philadelphia Museum of Art, which, under the directorship of the new president of the association, is developing its exhibits separately for the student and the public. This scheme—on the scale here adopted—is epoch-making for art museums; it savors of the best practice among science museums and, further, it has much to offer by way of example to these institutions as well as to art museums. A general session and one of the several group conferences were given over to this subject.

Another group conference—that of museum preparators—was responsible, during the meeting, for the organization of the new technical section of the association. Frank Tose, chief of exhibits of the California Academy of Science, was elected chairman.

More time than usual was devoted to problems of industrial museums. This circumstance was in response to the interests of two important new institutions—the Rosenwald Industrial Museum of Chicago and the Museums of Peaceful Arts of New York—and also in recognition of the growth of the National Museum in this field. One general session was the occasion of a symposium on the treatment of industry in exhibits of the four different kinds of museums.

The report rendered at the meeting by the treasurer, Mr. George D. Pratt, showed that the association had an income of approximately \$30,000 for operating in the year ending April 30 and that it had administered several special funds which—during the past six years—have shown receipts of more than a third of a

million dollars. For appropriations to the general and special funds, the report made acknowledgment to the Laura Spelman Rockefeller Memorial, the Rockefeller Foundation, the General Education Board, the Carnegie Corporation of New York and the Carnegie Endowment for International Peace.

The director's report, also rendered at the meeting, reviewed the progress of the association during the past six years, which have constituted a period of exploratory work and financial growth under generous subsidy. In these years the number of museums holding membership has doubled and the number of individuals has trebled, so that at present most of the active museums of the country are institution members and about eight hundred museum professionals and trustees are enrolled as individual members. This and other progress, as reflected in finances, has given the association a substantial grounding for its work in the future.

In commenting upon his report, at the opening session, the director said:

The work of our staff—both in office and field—is varied. We have published six volumes of a fortnightly newspaper, *The Museum News*, and also a series of monographs on museum work. We have made technical studies of museum methods, compiled information and published the results as books. Four of such volumes have appeared, one is in press and two others are in preparation. We have carried on a large correspondence, much of it giving information and advice. We have filled positions. We have helped to organize and develop new museums, we have endeavored to stimulate certain public officials and to discourage others. We have represented museums before city councils, state legislatures and the National Congress.

Our director has visited more than four hundred museums throughout the United States and in fifteen countries of Europe and South America. These travels have yielded material for books, have acquainted us intimately with museums, and have brought us into touch with associations and official agencies in the museum field both here and abroad.

With some of our special grants, we have financed university research on museum problems, made possible an official study of the educational possibilities of government lands, organized an important international exhibition, paid for an international commission on industrial art, and also, at a cost of \$226,000, we have built demonstration out-door museums in a state park and in three national parks. This last activity has been chiefly the result of the brilliant and untiring voluntary work of Dr. Hermon Carey Bumpus.

By such activities as these, the association is endeavoring to fulfil more largely each year the purpose for which it was created.

LAURENCE VAIL COLEMAN

Director